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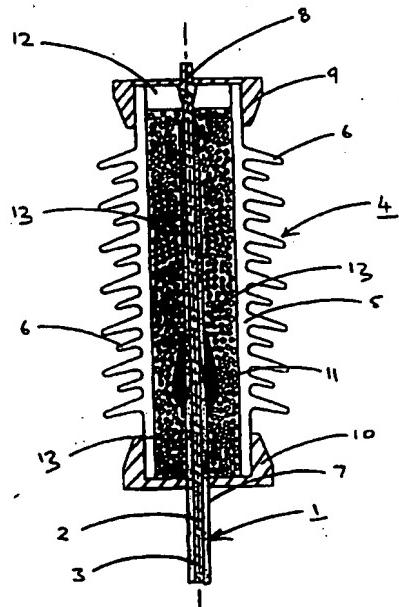
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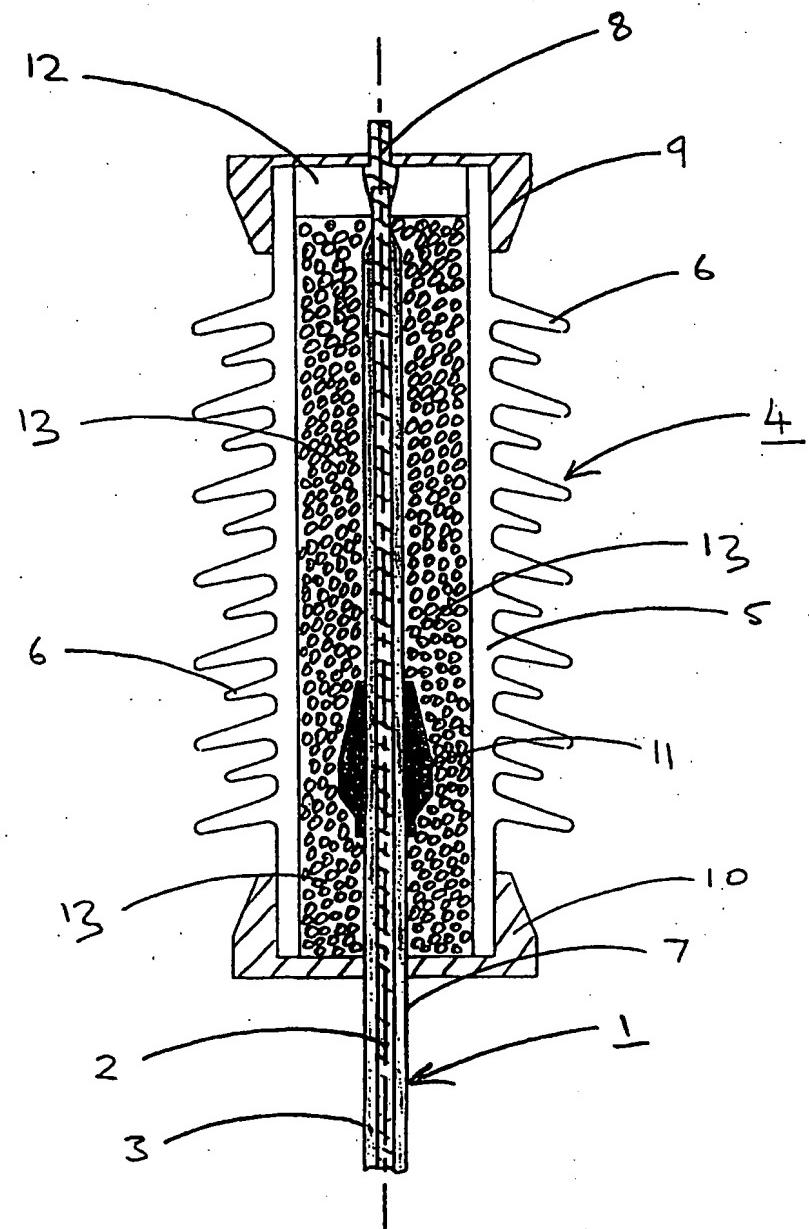
(54) Abstract Title  
**Electric cable termination with granular insulation**

(57) A termination (4) for an electrical power cable (1), including load carrying conductor (2) has an insulating outer member (5) through which the load carrying conductor runs longitudinally, and means for controlling electrical stress concentrations (6) within the outer member. Residual space (13) within the outer member is occupied by electrically insulating solid granules and interstices between the granules are filled with electrically insulating fluid. The granules may be made of a polymeric material (such as polyethylene, polypropylene, ethylene-propylene rubber or silicone rubber) or may be beads of glass, ceramic or epoxy resin. The insulating fluid may be silicone oil.



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A TERMINATION FOR ELECTRICAL CABLE

This invention relates to terminations for electrical power cables, for example, operating at voltages in the range from about 35 kilovolts to 500 kilovolts or above.

When an electrical power cable is connected to an overhead line, a transformer, switchgear, or other equipment, a suitable termination is required to manage the transition of the load-carrying conductor from the environment of the cable in which it is surrounded by high-quality, solid, insulating material of high electrical strength with electrical stress geometry strictly controlled by a concentric earth screen to one in which insulation is mainly provided by air at relatively low stress concentrations and uncontrolled geometry, while protecting the cable end from contamination, and, where applicable, from leakage of insulating fluids.

Typically, these terminations comprise tubular member, usually of ceramic insulating material, to provide adequate spacing from the high voltage at the end of to earth potential at the screen of the cable. The cable conductor, or an extension of it, runs down the central longitudinal axis of the tubular member, with a stress cone or other means provided in the annular space between the conductor and the tubular member for controlling electrical stress concentrations. Resilient mechanisms may also be provided to ensure that interfaces are under pressure.

While these components fill most of the space inside the tubular member, there are still residual spaces which need to be filled with a material having better electrical properties - primarily breakdown strength, that is the electrical stress concentration at which ionisation occurs leading ultimately to electrical breakdown - than air, to reduce the risk of electrical breakdown at exposed surfaces. Typically, a suitable insulating fluid such as silicone oil or a compressed gas (for example sulfur hexafluoride) are used, but this increases the cost of making the terminations. It

has also been known to use large, moulded, polymer shapes to occupy most of the space.

According to the present invention, there is provided a termination for an electrical power cable including a load carrying conductor, the termination comprising an insulating outer member through which the load carrying conductor, or an extension of it, runs substantially longitudinally, and means for controlling electrical stress concentrations within the outer member, characterised in that residual space within the outer member is occupied by electrically insulating solid granules and interstices between the granules are filled with electrically insulating fluid.

By "granules", there is meant particles having a greatest diameter in the range 0.5 to 8 mm and an aspect ratio not greater than 3.

The granules are preferably of a polymeric material that does not dissolve or swell unduly in the insulating fluid, for example, low density polyethylene, medium density polyethylene, high density polyethylene, polypropylene, ethylene polypropylene rubber or silicone rubber.

Alternatively beads of glass, ceramic or epoxy resin could be used.

The invention can bring significant cost savings due to the lower cost per unit volume of the granules compared to that of the insulating fluid, and, as the use of granules removes the requirement for moulding, is less expensive to produce than moulded shapes.

In addition, when granules of higher grade low density polyethylene are used in silicone oil, this can reduce the electrical stress in the fluid due to the lower relative permittivity of the granular material when compared to that of the fluid. Because of this lower electrical stress, higher stress cable designs can be accommodated. As the polymer granules will expand at a lesser rate than the silicone fluid, pressures within the termination will remain lower at high temperatures, which will reduce the risk of leakage. In

addition, the polymer granules have a better thermal conductivity than silicone fluid, and hence help reduce the temperature within the terminations, which may improve the service life of the termination.

5 The invention will now be described, by way of example only, with reference to the accompanying drawing, which is a schematic cross-section of a termination for a supertension power cable

A electrical cable 1, for carrying loads of between 66 10 kilovolts and 500 kilovolts (or above), comprises a load carrying conductor 2, and insulation 3. A termination 4 for the cable comprises a substantially tubular member 5, made of a ceramic insulating material. The tubular member 5 has a number of radially extending flanges 6, commonly referred to 15 as "sheds", to increase the length of the surface leakage path. The cable 1 is stripped back from the top end, exposing the insulation 3 to a position part way up the termination; an earth screen 7 continues on the outside of the insulation from this position. The cable conductor 2 runs 20 along the central axis of the tubular member 5 and enters a connector stalk 8 which passes through a top plate 9. The earth screen 7 passes through a baseplate 10 and finishes under the back of a stress cone 11. The top end of the tubular member 5 may enclose an air gap to accommodate 25 expansion.

The structure of the termination as described so far is that of a known termination, and, as such, its operation is already known to persons skilled in the art; except in so far as it is relevant to the present invention, the termination 30 will not be described in any further detail herein.

The remaining space 13 in the interior of the tubular member 5 are then filled with granules of clean, contaminant free, low density polyethylene, with the interstices between the granules being filled with silicone oil. Ideally the 35 granules would be spherical for easy flow and efficient filling, but granules as marketed for feeding to extruders or

moulding machines are satisfactory and more economical: these vary in shape depending on the design of the granulator and the speed at which it is operated, and may be roughly cylindrical or quite irregular. The granules used in the example are irregular in shape and typical granules have mutually perpendicular dimensions averaging about 4.4 by 4.0 by 2.5 mm (aspect ratio 1.8).

In making the termination, the residual spaces are preferably first filled with the granules and then the interstices between the granules filled with the silicone fluid.

As will be understood by persons skilled in the art, various modifications are possible within the scope of the present invention, for example, the use of granules with an insulating fluid can be applicable to other forms of terminations for electrical power cables.

## CLAIMS

1. A termination for an electrical power cable including a load carrying conductor, the termination comprising an insulating outer member through which the load carrying conductor, or an extension of it, runs substantially longitudinally, and means for controlling electrical stress concentrations within the outer member, characterised in that residual space within the outer member is occupied by electrically insulating solid granules and interstices between the granules are filled with electrically insulating fluid.
2. A termination as claimed in claim 1, wherein the solid granules are of a polymeric material.
3. A termination as claimed in claim 2, wherein the polymer is polyethylene.
4. A termination as claimed in claim 2, wherein the polymer is polypropylene.
5. A termination as claimed in claim 2, wherein the polymer is ethylene-propylene rubber.
- 20 6. A termination as claimed in claim 2, wherein the polymer is silicone rubber.
7. A termination as claimed in claim 1 wherein the granules are beads of glass, ceramic or epoxy resin.
8. A termination as claimed in any one of claims 1-7  
25 in which the granules are approximately spherical.
9. A termination as claimed in any one of claims 1-7 in which the granules are approximately cylindrical.
10. A termination as claimed in any one of claims 1-7 in which the granules are irregular in shape.
- 30 11. A supertension cable termination substantially as described with reference to the Example.



Application No: GB 9900190.1  
Claims searched: 1-11

Examiner: Richard Nicholls  
Date of search: 3 August 1999

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.Q): H2C (CBG, CBJ, CBT)

Int Cl (Ed.6): H02G 15/06, 15/064

Other: Online databases : WPI, EPODOC, PAJ

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
A	US 4060583 A (GROVES) see especially the figure	

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| X Document indicating lack of novelty or inventive step   | A Document indicating technological background and/or state of the art.  |
| Y Document indicating lack of inventive step if combined with one or more other documents of same category. | P Document published on or after the declared priority date but before the filing date of this invention.          |
| & Member of the same patent family  | E Patent document published on or after, but with priority date earlier than, the filing date of this application. |